VEHICLE GUIDANCE TECHNOLOGY

Vehicle guidance technology enables AGVs to move and navigate **safely and accurately** within a predefined or dynamic environment, often without human control.

Main Categories of Guidance Technologies

1. Wired Guidance

- **How it works:** Wires are embedded in the floor. The AGV senses signals from the wire.
- **Use:** Traditional manufacturing layouts.
- **Pros:** Stable and accurate.
- **Cons:** Inflexible and hard to reconfigure.

2. Magnetic Tape Guidance

- **How it works:** Magnetic tape on the floor is sensed by magnetic sensors on the AGV.
- **Use:** Warehouses, retail automation.
- **Pros:** Easy to install and modify.
- **Cons:** Susceptible to wear and misalignment.

3. Optical Line Following

- **How it works:** AGVs follow a colored or reflective line on the floor using optical sensors or cameras.
- **Use:** Light-duty environments.
- **Pros:** Inexpensive and simple.
- **Cons:** Poor performance in dirty or poorly lit areas.

4. Laser Guidance (Lidar-Based)

- **How it works:** A laser scanner maps the environment using reflectors or natural features.
- **Use:** Dynamic and complex layouts.
- **Pros:** High precision and flexibility.
- **Cons:** High initial cost; requires clear line of sight.

5. Inertial Navigation

- **How it works:** Gyroscopes and accelerometers track the AGV's movement relative to a known point.
- **Use:** Environments with limited external references.

- **Pros:** No need for floor or wall markers.
- **Cons:** Accumulates errors over time (drift).

6. Vision-Based Navigation

- **How it works:** Cameras capture real-time images. AI or computer vision interprets the environment.
- **Use:** Advanced AGVs and AMRs (Autonomous Mobile Robots).
- **Pros:** Very flexible and intelligent.
- **Cons:** Requires advanced processing and lighting control.

7. GPS / RTLS Guidance

- **How it works:** Uses satellite signals (GPS) or indoor positioning (RTLS) to determine location.
- **Use:** Outdoor AGVs or large warehouses.
- **Pros:** Covers large areas.
- **Cons:** GPS isn't reliable indoors; RTLS systems can be expensive.

Emerging Trends in Guidance Tech

- **Sensor Fusion:** Combining multiple sensors (e.g., laser + vision) for better reliability.
- **AI-Based Path Planning:** AGVs make decisions based on real-time environment data.
- **SLAM (Simultaneous Localization and Mapping):** AGVs map their environment while navigating through it.

VEHICLE MANAGEMENT & SAFETY

Vehicle management safety—especially in the context of **automated systems like AGVs or fleet vehicles**—involves a combination of **technologies, policies, and best practices** to ensure safe and efficient operation. Here's a breakdown of key aspects:

Vehicle Management Safety Measures

◈ 1. Collision Avoidance Systems

- Use of **sensors** (e.g., LiDAR, ultrasonic, radar) and **vision systems** to detect obstacles.
- **Emergency braking systems** to stop vehicles when obstacles are detected.
- Real-time **path planning** to reroute if necessary.

2. Speed Control

- AGVs and fleet vehicles are limited to **safe speed limits** based on environment (factory floor, warehouse, etc.).
- **Dynamic speed adjustment** in crowded areas or around human workers.

3. Zoning and Navigation Safety

- Designation of **safe zones** and **no-go zones** within the operating area.
- Use of **geo-fencing** and **virtual barriers**.
- Navigation based on **QR codes, magnetic strips, SLAM (Simultaneous Localization and Mapping)**, etc.

4. Traffic Management and Scheduling

- Use of **fleet management software** to schedule vehicle routes and avoid traffic congestion.
- **Priority rules** for intersections or tight corridors.
- Coordination to prevent AGV collisions and bottlenecks.

5. Human Interaction Safety

- **Audible alarms, flashing lights, and visual indicators** to alert humans to moving vehicles.
- **Slow-down zones** in high human activity areas.
- **Emergency stop buttons** accessible to workers nearby.

6. Regular Maintenance and Diagnostics

- Scheduled inspections and **predictive maintenance** based on usage data.
- Real-time **monitoring of battery health, tire wear, and sensor performance**.

7. Training and SOPs

- Operator and technician training on AGV systems and emergency procedures.
- Clear **Standard Operating Procedures (SOPs)** for AGV use, manual overrides, and response during system failure.

8. Cybersecurity Measures

- Protection against hacking or unauthorized control of autonomous vehicles.
- Secure wireless communication between vehicles and control systems.

9. Compliance with Safety Standards

- Adherence to international safety standards like:
    - **ISO 3691-4**: Safety requirements for driverless industrial trucks (AGVs).
    - **ISO 10218 / ISO/TS 15066**: For collaborative robotics where applicable.
    - **ANSI/ITSDF B56.5**: Safety standard for AGVs.